Changing the Design Rules of Rubber to Create Lighter Weight, More Fuel-Efficient Tires

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MOLECULAR REBAR® DESIGN

Project ID: MAT257

PROJECT OVERVIEW

Timeline
Project Start Date: June 2021
Project End Date: March 2022
Percent Complete: 100%

Barriers & Technical Targets
· Improve reinforced elastomer composites
· Improve wear resistance and energy efficiency for electric vehicle tires

Budget
Total Funding: $197,359

Partners
None. Short-term project

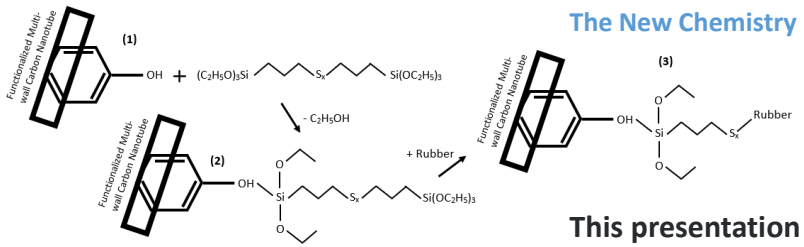
RELEVANCE

Impact to Tire Tread Compound
Using MR, the new elastomer composite physical properties have improved **abrasion resistance (25%+)**, a reduced **rolling resistance (20%)**, and a **density reduction (5-7%)**.

APPROACH

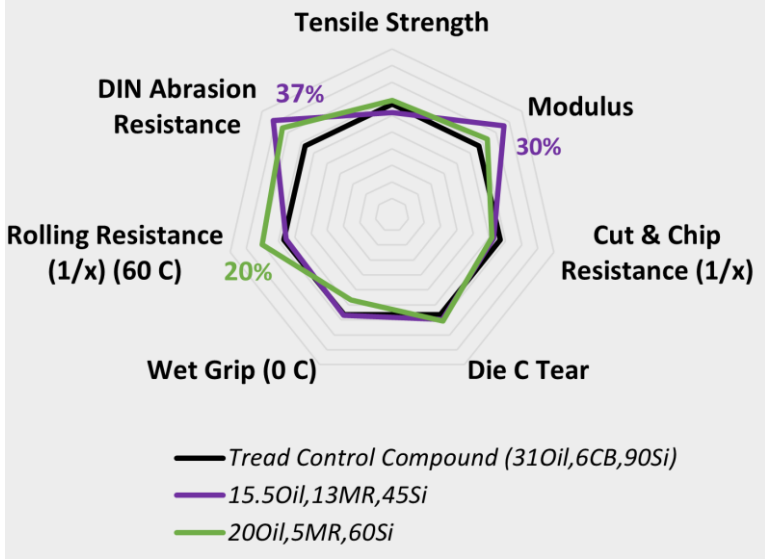
Objective
Chemically modify discrete carbon nanotubes (called MOLECULAR REBAR® or MR) to add step-change property improvements to elastomer composite compounds used in tire treads. Demonstrate that MR technology can be used in silica-filled tread compound formulas to improve wear resistance and to use less energy-greatly desired property improvements for electric vehicle (EV) tires.

The New Chemistry



TECHNICAL PROGRESS

SSBR-BR-Si-Si69 Tread Formula with MR



- 20% improved rolling resistance = 7% gain in EV efficiency = ~1.5 cents/mile savings in EV operating cost.
- Improving EV efficiency by 7% will save 32,300 MWh of electricity in 2030- enough to power ~1 million homes.
- Target markets: tire manufacturers, EV fleet owner/operators, consumer-owners of EVs

FUTURE RESEARCH

Proposed Phase II Work

- Design commercially-viable prototype product form of the functionalized Molecular Rebar, for delivery into tire compound processes
- Develop 'Guiding Principles of Use' for the material: focus on composite composition –property relationships.
- Design, build, and test prototype tires. Demonstrate that tires last 25%+ longer and EV is ~7%+ more energy efficient.

"Any proposed future work is subject to change based on funding levels"

SUMMARY

Demonstrated Innovations in Composite Properties

- Organosilane modified multi-wall MR that covalently bonds to the elastomer during curing, rather than typical weaker attraction using physisorption (Van Der Waal's) effects.
- Reduction of filler materials used in the tire compounds using modified MR-fundamentally altering material properties.
- Covalently bound Molecular Rebar is 3X to 10X as reinforcing as incumbent reinforcing filler precipitated silica.

31 PHR of Oil- Constant	13 PHR MR or 45 PHR Silica		26 PHR MR or 90 PHR Silica		Difference in PHR	Δ 100% Modulus / Unit RR	Δ 100% Modulus / PHR
	Initial 100% Modulus (MPa)	*Initial Rolling Resistance (RR)*	*Final 100% Modulus (MPa)*	*Final Rolling Resistance (RR)*			
Molecular Rebar 13 – 26 PHR	2.6	0.074	7.7	0.1796	13	48.3	0.39
Silica 45 – 90 PHR	2.4	0.061	4	0.1736	45	14.2	0.036

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